Tensorflow
What is Tensorflow?

➢ **TensorFlow** is a Python-friendly open source library for numerical computation that makes machine learning faster and easier.

➢ TensorFlow computations are expressed as stateful dataflow graphs.

➢ The name **TensorFlow** derives from the operations neural networks perform on multidimensional data arrays. These arrays are referred to as “tensors”.

➢ Benefits: More flexibility, Control over network model
Tensor of Dimensions [5]

Input Layer

Hidden Layers

Output Layer

Tensor

Data Flow Graph

add

input

mul

add

5

9

6

4

4

24

33
Starting in 2011, Google Brain built DistBelief as a proprietary machine learning system based on deep learning neural networks, later became Tensorflow.

Nov 2017, Google announced a software stack specifically for Android development, TensorFlow Lite, beginning with Android Oreo.
Specific problems it's designed to solve:

- Computer Vision - Image Detection
- Voice Recognition
- Auto Translation (Google Translate)
- Time Series Prediction
Leverage Ubiquitous Nature

Tensorflow + Android ➔ Powerful Android apps.

Harvest the rich sensor data available on mobile devices.

Example: Human Activity Recognition (HAR)
TensorFlow Lite is one of the solutions for running machine learning models on mobile and embedded devices.
ARCHITECHTURE

- **JAVA API:**
  A convenience wrapper around the C++ API on Android.

- **C++ API:**
  Loads the TensorFlow Lite Model File and invokes the interpreter.
To Start: Build a model
Convert model to .tflite

Use TOCO: TocoConverter

```python
import tensorflow as tf

img = tf.placeholder(name="img", dtype=tf.float32, shape=(1, 64, 64, 3))
const = tf.constant([1., 2., 3.]) + tf.constant([1., 4., 4.])
val = img + const
out = tf.identity(val, name="out")

with tf.Session() as sess:
    converter = tf.contrib.lite.TocoConverter.from_session(sess, [img], [out])
tflite_model = converter.convert()
open("converted_model.tflite", "wb").write(tflite_model)
```
Convert model .tflite

Train Model

Graph Def (.pb)

Checkpoints (.ckpt)

Saved Model (.pb)

Freeze Graph

Frozen Graph (.pb)

Optimize For Inference

Optimized Frozen Graph (.pb)

Convert to TFLite

TFLite (.tflite)
Building an Android App with Tensorflow lite

Step 1: Add the tensorflow-lite libraries to your app.

```java
compile 'org.tensorflow:tensorflow-lite:+'
```

Step 2: Import the Tensorflow Interpreter.

```java
import org.tensorflow.lite.Interpreter;
```
Step 3: Create an instance of the interpreter.

```java
protected Interpreter tflite;
tflite = new Interpreter(loadModelFile(activity));
```

Step 4: Memory-map the model file in Assets.

```java
private MappedByteBuffer loadModelFile(Activity activity) throws IOException {
    AssetFileDescriptor fileDescriptor = activity.getAssets().openFd(getModelPath());
    FileInputStream inputStream = new FileInputStream(fileDescriptor.getFileDescriptor());
    FileChannel fileChannel = inputStream.getChannel();
    long startOffset = fileDescriptor.getStartOffset();
    long declaredLength = fileDescriptor.getDeclaredLength();
    return fileChannel.map(FileChannel.MapMode.READ_ONLY, startOffset, declaredLength);
}
```
Step 5: Run the method on the interpreter.

tflite.run(imgData, labelProbArray);
Real World Example

- Yolo
- Skin Cancer Recognizer

![Image of a mobile phone with a skin cancer recognition app open, showing a diagnosis of 98% Malignant Pigmented, 0% Malignant Epidermal, and 0% Benign Epidermal.]
Real World Example

Companies using TensorFlow Lite

"TensorFlow Lite helped us introduce machine learning and AI into our app in an easy and streamlined way. We could reduce the size of our models while keeping the accuracy high. This helped us create an amazing fishing experience for our users by allowing them to identify any fish species with just a photo."
Turkey!

dcorrado to me

Hi all,

We wanted to invite you to join us for an early Thanksgiving on November 22nd, beginning around 2PM. Please bring your favorite dish! RSVP by next week.

Dave

Server issues

Dan Mané to me

Hi team,

The server appears to be dropping about 10% of requests (see attached dashboards). There hasn’t been a new release since last night, so I’m not sure what’s going on. Is anyone looking into this?

...
References

- Wolber, David; Abelson, Hal; Spertus, Ellen; Looney, Liz (May 2011), App Inventor for Android: Create Your Own Android Apps, O'Reilly, ISBN 978-1-4493-9748-7
Sensor Data : Machine Learning

Activity signal → Feature extraction → Model training → Activity inference

- Activity signal: Location, Bluetooth, Accelerometer, Pedometer
- Feature extraction: Mean, Min, Max, Range, Variance, Time domain, Frequency domain, DC, Amplitude, Kurtosis, Skewness, Energy
- Model training: Naive Bayes, Neural network, Decision tree, Gaussian Mixture, Hidden Markov model, Support vector machine
- Activity inference: Upstairs, Running, Riding bike, Having coffee, Watching TV
Using Deep Learning model